

**Sampling the fish community of Big Creek, Norfolk  
County, Ontario, 2008**

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## ABSTRACT

Fisheries and Oceans Canada conducted a fish community survey of Big Creek, Norfolk County in the summer and fall of 2008. A total of 21 sites were sampled using a variety of sampling methods, including backpack electrofishing (two sites), boat electrofishing (eight sites), bag seining (four sites), and boat seining (seven sites). The survey was focused primarily on the areas accessible by boat, resulting in more intensive sampling of the lower Big Creek watershed. However, site selection also considered locations where Lake Chubsucker had been previously recorded. A total of 919 fishes representing 34 species were captured, including four species at risk. Eastern Sand Darter, *Ammocrypta pellucida* (Threatened), Pugnose Shiner, *Notropis anogenus* (Endangered) and Grass Pickerel, *Esox americanus vermiculatus* (Special Concern) were detected at two sites each, while Lake Chubsucker, *Erimyzon sucetta* (Endangered) was detected at a single site.

## RÉSUMÉ

Pêches et Océans Canada a mené un relevé de la communauté de poissons de Grand Crique, dans le comté de Norfolk, au printemps et à l'automne 2008. Un total de 21 sites ont été échantillonnés au moyen de différentes méthodes, comme la pêche électrique à l'aide d'appareils portatifs (2 sites), la pêche électrique en bateau (8 sites), la senne manuelle (4 sites) et la senne en bateau (7 sites). Le relevé portait surtout sur les zones accessibles en bateau et a donc donné lieu à un échantillonnage plus intensif du bassin versant du cours inférieur du Grand Crique. Cependant, la sélection des sites a aussi tenu compte des sites où le sucet de lac avait déjà été observé. On a capturé, au total, 919 poissons de 34 espèces, dont quatre espèces en péril. Le dard de sable (*Ammocrypta pellucida*) [menacé], le méné camus (*Notropis anogenus*) [en voie de disparition] et le crapet sac-à-lait (*Esox americanus vermiculatus*) [préoccupant] ont été détectés à deux sites chacun, et le sucet de lac (*Erimyzon sucetta*) [en voie de disparition] a été détecté à un seul site.

## INTRODUCTION

Big Creek is the largest sub-watershed in the Long Point Region, consisting of a total of 750 square kilometers<sup>1</sup>. The creek flows south through Delhi before it enters Lake Erie near Port Rowan (Figure 1). Big Creek and its tributaries are of particular interest for fish conservationists as historical records exist from this system for four fish species at risk: Lake Chubsucker, *Erimyzon sucetta*, Eastern Sand Darter, *Ammocrypta pellucida*, Pugnose Shiner, *Notropis anogenus*, and Grass Pickerel, *Esox americanus vermiculatus*.

Lake Chubsucker was historically recorded from the Big Creek watershed in 1960, 1972-1974 and 1979 from Silverthorn Creek, Stoney Creek, Lynedock Creek, and Trout Creek (tributaries of Big Creek) (Bouvier and Mandrak 2011). Many of the historic Lake Chubsucker sites have not been re-visited since the time of the initial detection. Eastern Sand Darter was first recorded from Big Creek in 1923, and subsequently detected in 1955. Six sampling attempts occurred in this system from 1973 to 2004 and failed to detect Eastern Sand Darter. Unlike Lake Chubsucker, and Eastern Sand Darter, there are no historic records for Pugnose Shiner from the Big Creek watershed. The first detection of Pugnose Shiner in this system occurred in 2007 when individuals were recorded at the highway 59 bridge crossing (D.A.R. Drake, 867 Lakeshore Rd, Burlington ON, unpublished data). Similarly, Grass Pickerel were not historically known to occupy the Big Creek watershed. The first Grass Pickerel record was obtained when a single individual was captured in the lower section of the creek in 2002 (Beauchamp et al. 2012), while additional vouchers were recorded from the upper portion of Big Creek in 2004 near Rowan Mills (Beauchamp et al. 2012).

Sampling of historic Lake Chubsucker and Eastern Sand Darter capture sites is necessary to validate the persistence of these species in the watershed. In addition, increased sampling effort throughout the Big Creek watershed is necessary to gain a better understanding of the current distribution and abundance of all four fish species at risk known to occupy this watershed. The focus of this study was to increase our understanding of the distribution and habitat use of Lake Chubsucker, Eastern Sand Darter, Pugnose Shiner and Grass Pickerel, all of which are currently listed on Schedule 1 of the *Species at Risk Act*.

## METHODS

### SAMPLING

#### *Electrofishing sampling*

Backpack electrofishing was conducted using a Smith-Root Model LR24 backpack unit (Appendix 1). Sampling effort ranged from 521 to 843 s of electrofishing, generally at a rate of 2-4 s/m. Sampling effort was variable among sites due to habitat complexity and the amount of habitat available to sample (e.g., less habitat to sample during low water depths). Fishes were captured in nets as they were stunned, and were placed in buckets filled with water.

Boat electrofishing was conducted using a 4.27 m jon boat equipped with a Smith Root 5.0 GPP (gas powered pulsator, 5.0 kW generator, a single-boom anode, and a single netter). Sampling

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<sup>1</sup> [http://www.sourcewater.ca/swp\\_watersheds\\_longpoint/Characterization\\_summary\\_LPR.pdf](http://www.sourcewater.ca/swp_watersheds_longpoint/Characterization_summary_LPR.pdf)

effort varied between sites from 422 to 499 s of electrofishing. Stunned fishes were captured by the netter.

### *Seine sampling*

Two types of seining occurred. The first involved an 8.5 m x 2 m bag seine with 6.35 mm ace mesh. The second type involved a 15.24 m by 2.67 m boat seine with 6.35 mm ace mesh (Appendix 1). A total of three hauls were performed at each of the four sites sampled by bag seine. The number of hauls varied from one to four at the seven sites sampled by boat seine. This variability was due to the amount of habitat that could be effectively sampled (i.e., additional hauls were completed at sites where habitat was abundant or when SAR were observed, less hauls were completed when debris limited the habitat that could be sampled). All hauls were performed in the direction of flow, from upstream to downstream. Fishes were transferred from the seine net into bins filled with water.

For all gear types (electrofishing/seining), fishes were identified, measured, and returned to the creek. Voucher specimens of each species were preserved in 10% formalin for laboratory verification.

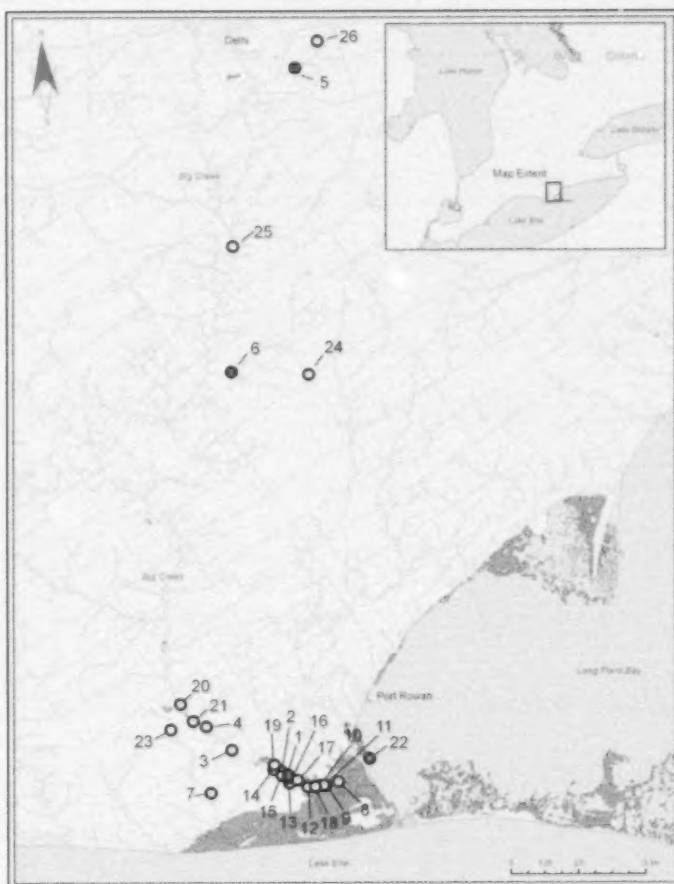


*Figure 1. Sites sampled in Big Creek watershed in 2008. See Appendix 6 for detailed site descriptions. Map numbers correspond to site numbers in Appendix 1-6. Red sites are historical locations not sampled, and yellow are historical sites where sampling occurred.*

## **HABITAT DATA COLLECTION**

Habitat variables recorded at each site included: air temperature (°C), water temperature (°C), conductivity ( $\mu$ S), Secchi depth (m), aquatic vegetation (% emergent, % floating, % submergent) (Appendix 2), water depth (m), sampling depth (m), sampling distance from shore (m), substrate components (% based on the Wentworth scale), stream width (m), flow rate (subjectively classified as no flow, slow flow, medium flow, or fast flow), habitat type (riffle, run, pool) (Appendix 3), riparian vegetation (%), bank slope (%) and channel cover (%) (Appendix 4).

## **RESULTS**

### **SAMPLING**

#### *Backpack electrofishing*

Two sites were sampled by backpack electrofishing on August 20, 2008 and resulted in a total effort of 1364 sec. Site 5 was shocked for 843 s and Site 6 for 521 s. A total of 22 fishes representing five species were captured (Tables 1 and 2, Appendix 5). The catch per unit effort (CPUE) was 0.016 fishes/sec (Table 1). No species at risk were captured by backpack electrofishing.

#### *Boat electrofishing*

A total of eight sites were sampled by boat electrofishing on October 15, 2008. The total boat electrofishing effort was 3740 s, with an average of 467.5 s/site (Table 1). A total of 346 fishes, representing 16 species were captured (Tables 1 and 2, Appendix 5). The CPUE was 0.093 fishes/sec (Table 1). One species at risk, Grass Pickerel, was captured at two sites (11 and 16) while boat electrofishing (Figure 2).

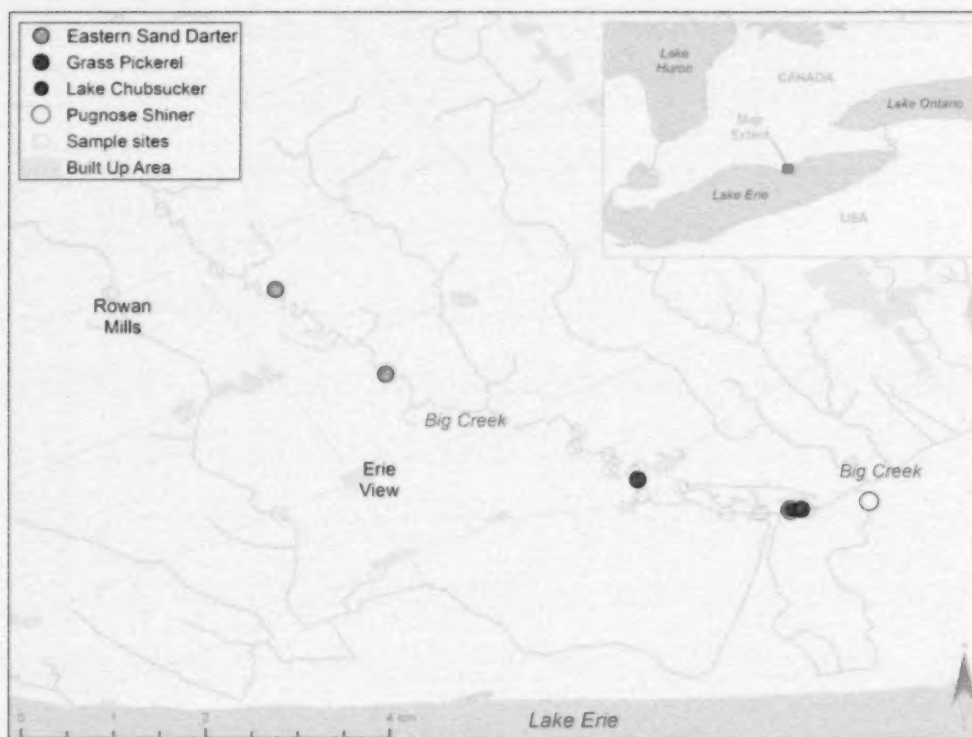


Figure 2. Sites where species at risk were detected during the 2008 survey of the Big Creek watershed.

#### Bag seine

A total of four sites were sampled by bag seine. Sampling occurred on August 20, and October 16, 2008. A total of twelve seine net hauls were complete - three at each site. A total of 85 fishes were captured, representing seven species and a CPUE of 7.08 fishes/haul (Table 1 and 2, Appendix 5). No species at risk were captured.

#### Boat seine

A total of seven sites were sampled by boat seine. Effort was not recorded for Site 9 or Site 10; therefore, these sites were omitted from the sampling effort calculations. A total of 463 fishes were captured, representing 22 species, including three species at risk (Eastern Sand Darter, Lake Chubsucker, and Pugnose Shiner; Table 1 and 2, Figure 2, Appendix 5). The total effort, excluding sites 9 and 10, was 14 hauls, averaging 2.8 hauls per site. The CPUE was 24.21 fishes/haul.

Table 1. Summary of sampling effort during 2008 Big Creek sampling.

| Gear type                       | Bag Seine | Boat seine | Backpack electrofishing | Boat electrofishing |
|---------------------------------|-----------|------------|-------------------------|---------------------|
| Number of sites sampled         | 4         | 7          | 2                       | 8                   |
| Total number of fishes          | 85        | 463        | 22                      | 348                 |
| Species richness                | 7         | 22         | 5                       | 16                  |
| Fish species at risk detected   | 0         | 3          | 0                       | 1                   |
| Unique species                  | 1         | 13         | 2                       | 6                   |
| Total effort (hauls or seconds) | 12        | 14*        | 1364                    | 3740                |
| Mean effort (hauls or seconds)  | 3         | 2.8**      | 682                     | 467.5               |
| CPUE (fish/haul, fish/sec)      | 7.08      | 24.21**    | 0.016                   | 0.093               |

\*effort was not recorded for Sites 9 and 10; \*\*excluding Sites 9 and 10

Table 2. Summary of species captured during the 2008 Big Creek sampling by backpack electrofishing (BPEF), boat electrofishing (BEF), bag seine (BaS), and boat seine (BoS). Current status under the Species at Risk Act are provided, where EN: Endangered; TH: Threatened; and, SC: special concern. Common and scientific names are provided according to Page et al. (2013) and are listed in taxonomic order.

| Common name         | Scientific name                     | Status | BPEF      | BEF        | BaS       | BoS        | Total      |
|---------------------|-------------------------------------|--------|-----------|------------|-----------|------------|------------|
| Gizzard Shad        | <i>Dorosoma cepedianum</i>          |        | 0         | 0          | 0         | 1          | 1          |
| Spotfin Shiner      | <i>Cyprinella spiloptera</i>        |        | 0         | 0          | 0         | 7          | 7          |
| Common Carp         | <i>Cyprinus carpio</i>              |        | 0         | 12         | 0         | 0          | 12         |
| Golden Shiner       | <i>Notemigonus crysoleucas</i>      |        | 0         | 0          | 0         | 1          | 1          |
| Pugnose Shiner      | <i>Notropis anogenus</i>            | EN     | 0         | 0          | 0         | 6          | 6          |
| Emerald Shiner      | <i>Notropis atherinoides</i>        |        | 0         | 5          | 0         | 7          | 12         |
| Blacknose Shiner    | <i>Notropis heterolepis</i>         |        | 0         | 0          | 0         | 11         | 11         |
| Spottail Shiner     | <i>Notropis hudsonius</i>           |        | 0         | 1          | 0         | 1          | 2          |
| Mimic Shiner        | <i>Notropis volucellus</i>          |        | 0         | 4          | 2         | 23         | 29         |
| Bluntnose Minnow    | <i>Pimephales notatus</i>           |        | 0         | 1          | 0         | 111        | 112        |
| Fathead Minnow      | <i>Pimephales promelas</i>          |        | 0         | 0          | 1         | 0          | 1          |
| Blacknose Dace      | <i>Rhinichthys atratulus</i>        |        | 4         | 0          | 0         | 0          | 4          |
| Creek Chub          | <i>Semotilus atromaculatus</i>      |        | 1         | 0          | 56        | 0          | 57         |
| White Sucker        | <i>Catostomus commersonii</i>       |        | 3         | 2          | 18        | 0          | 23         |
| Lake Chubsucker     | <i>Erimyzon sucetta</i>             | EN     | 0         | 0          | 0         | 2          | 2          |
| Brown Bullhead      | <i>Ameiurus nebulosus</i>           |        | 0         | 1          | 0         | 0          | 1          |
| Rainbow Trout       | <i>Oncorhynchus mykiss</i>          |        | 7         | 1          | 0         | 0          | 8          |
| Grass Pickerel      | <i>Esox americanus vermiculatus</i> | SC     | 0         | 2          | 0         | 0          | 2          |
| Northern Pike       | <i>Esox lucius</i>                  |        | 0         | 6          | 4         | 5          | 15         |
| Central Mudminnow   | <i>Umbra limi</i>                   |        | 0         | 1          | 0         | 0          | 1          |
| Brook Silverside    | <i>Labidesthes sicculus</i>         |        | 0         | 307        | 3         | 162        | 472        |
| Banded Killifish    | <i>Fundulus diaphanus</i>           |        | 0         | 1          | 0         | 0          | 1          |
| Mottled Sculpin     | <i>Cottus bairdii</i>               |        | 8         | 0          | 0         | 0          | 8          |
| Rock Bass           | <i>Ambloplites rupestris</i>        |        | 0         | 1          | 0         | 5          | 6          |
| Pumpkinseed         | <i>Lepomis gibbosus</i>             |        | 0         | 0          | 0         | 33         | 33         |
| Bluegill            | <i>Lepomis macrochirus</i>          |        | 0         | 0          | 0         | 8          | 8          |
| Sunfish hybrid      | <i>Lepomis sp.</i>                  |        | 0         | 0          | 0         | 1          | 1          |
| Largemouth Bass     | <i>Micropterus salmoides</i>        |        | 0         | 2          | 0         | 25         | 27         |
| Eastern Sand Darter | <i>Ammocrypta pellucida</i>         | TH     | 0         | 0          | 0         | 2          | 2          |
| Johnny Darter       | <i>Etheostoma nigrum</i>            |        | 0         | 0          | 0         | 16         | 16         |
| Yellow Perch        | <i>Perca flavescens</i>             |        | 0         | 0          | 1         | 22         | 23         |
| Blackside Darter    | <i>Percina maculata</i>             |        | 0         | 0          | 0         | 1          | 1          |
| Freshwater Drum     | <i>Aplodinotus grunniens</i>        |        | 0         | 1          | 0         | 0          | 1          |
| Round Goby          | <i>Neogobius melanostomus</i>       |        | 0         | 0          | 0         | 13         | 13         |
| <b>Total</b>        |                                     |        | <b>23</b> | <b>348</b> | <b>85</b> | <b>463</b> | <b>919</b> |

Grass Pickerel was detected at two sites, each of which was a shallow (2 m), heavily vegetated site with low flow. Pugnose Shiner was detected at two heavily vegetated sites with silt substrate, low flow velocity and secchi depths ranging from 0.29 m to 0.35 m. Lake Chubsucker was detected at a single site that was dominated by submerged vegetation (90% coverage), had silt substrate, and slow flow. Eastern Sand Darter was detected at two sites in slow flowing runs with silt substrate and that had no aquatic vegetation coverage.

## DISCUSSION

The 2008 sampling of the Big Creek watershed in Norfolk County was conducted to evaluate the current status of species at risk known to be present in the watershed. Sampling was conducted using a variety of gears, including bag seine, boat seine, backpack electrofishing, and boat electrofishing. The sampling of Big Creek was primarily conducted in the lower navigable reaches of the watershed. While boats were used to access the majority of sites, sampling with seines or by backpack electrofishing was restricted to wadeable areas. While several sites were sampled throughout the lower reaches of Big Creek, water depth, substrate composition, and woody debris limited wadeable sampling throughout much of the navigable waters (Appendix 3). Additionally, low water levels in 2008 left several sites in the upper reaches of the Big Creek watershed dry; therefore, sampling could not be conducted at all the sites with historical species at risk records (Appendix 6).

In total, 34 species of fishes were recorded. Four species at risk were detected during the sampling: Eastern Sand Darter, Lake Chubsucker, Grass Pickerel and Pugnose Shiner. Boat seining was successful in capturing three of these species at risk, while boat electrofishing was the only other sampling gear successful at detecting a species at risk (i.e., Grass Pickerel).

Eastern Sand Darter was captured at two sites (Sites 3, 4). Both sites were free of aquatic vegetation, had substrates composed primarily of silt, and were located in runs with low flow. Two Eastern Sand Darters were detected during this survey. Previous records indicated that Eastern Sand Darter had been captured both upstream and downstream of the 2008 collection sites (Bouvier and Mandrak 2010).

Lake Chubsucker was only detected at one site (Site 10). It has also been previously recorded in Big Creek (COSEWIC 2008), and is known to have similar habitat preferences as Pugnose Shiner, which was also caught at Site 10. While Lake Chubsucker had been historically recorded from the upper tributaries of the Big Creek watershed, none were collected during the 2008 sampling, and the species is presumed to be extirpated from the upper watershed (COSEWIC 2008). Unfortunately, four historical sampling sites could not be sampled because there was no water present during the site visit (Sites 23-26; Figure 1, Appendix 6). This highlights the ongoing threat of habitat degradation and loss due to agricultural drainage activities (Bouvier and Mandrak 2011). Sampling of the tributaries has not produced any additional records since those collected between 1960 and 1979 (COSEWIC 2008).

Grass Pickerel was caught at two sites (Sites 11, 16). A single Grass Pickerel was captured at both sites, which were sampled by boat electrofishing. Both sites were 100% vegetated, exhibited low flow, and had a water depth of 2 m. Grass Pickerel has been documented in the Long Point area (COSEWIC 2005a), and are associated with shallow, heavily vegetated areas with low flow.

Pugnose Shiner was captured at two sites (Sites 8, 10). Both sites were 100% vegetated, had low flow and were dominated by silt substrates, with secchi depth readings of 0.29 m and 0.35 m, respectively. Pugnose Shiner presence in Long Point Bay (and Big Creek) has been previously documented (Holm and Mandrak 2002) and, specifically, in heavily vegetated areas with low flow and clear water. The continued presence of Pugnose Shiner in the Long Point Bay area, and specifically in the Big Creek watershed, is a positive result following the failure to collect any specimens during 2002 sampling (Holm and Mandrak 2002). The presence of Pugnose Shiner in Big Creek appears to be an extension of the population known to persist in Long Point Bay (COSEWIC 2013).

The fish community sampling of Big Creek in 2008 was successful in detecting four fish species at risk (one Endangered species, two Threatened species, and a species of Special Concern, currently listed under the *Species at Risk Act*). Lake Chubsucker is presumed to be extirpated from the upper tributaries of the Big Creek watershed as historic sites no longer provide suitable habitat for this species. Further sampling of the Big Creek watershed is recommended to determine the distributional extent of all species at risk, including Spotted Gar, *Lepisosteus oculatus*, and Warmouth, *Lepomis gulosus*, that were not detected during this survey but are known to occupy the watershed (COSEWIC 2005b, c).

### ACKNOWLEDGMENTS

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Appendix 1. Description of sampling methods for 2008 Big Creek sampling. Site # corresponds to Figure 1.

| Site # | Date      | Capture method         | Duration     | Quantification of effort | Description of method                                |
|--------|-----------|------------------------|--------------|--------------------------|------------------------------------------------------|
| 1      | 19-Aug-08 | Boat seine             | 3            | Haul                     | Boat Seine, 6.35mm Ace mesh, Length - 15.24m         |
| 2      | 19-Aug-08 | Boat seine             | 3            | Haul                     | Boat Seine, 6.35mm Ace mesh, Length - 15.24m         |
| 3      | 19-Aug-08 | Boat seine             | 1            | Haul                     | Boat Seine, 6.35mm Ace mesh, Length - 15.24m         |
| 4      | 19-Aug-08 | Boat seine             | 3            | Haul                     | Boat Seine, 6.35mm Ace mesh, Length - 15.24m         |
| 5      | 20-Aug-08 | Backpack electrofisher | 843          | Seconds                  | Smith-Root, Model LR-24 Backpack Electrofishing Unit |
| 6      | 20-Aug-08 | Backpack electrofisher | 521          | Seconds                  | Smith-Root, Model LR-24 Backpack Electrofishing Unit |
| 7      | 20-Aug-08 | Bag seine (1)          | 3            | Haul                     | Bag Seine, 6.35mm Ace mesh, Length - 8.5m            |
| 8      | 21-Aug-08 | Boat seine             | 4            | Haul                     | Boat Seine, 6.35mm Ace mesh, Length - 15.24m         |
| 9      | 21-Aug-08 | Boat seine             | not recorded |                          | Boat Seine, 6.35mm Ace mesh, Length - 15.24m         |
| 10     | 21-Aug-08 | Boat seine             | not recorded |                          | Boat Seine, 6.35mm Ace mesh, Length - 15.24m         |
| 11     | 15-Oct-08 | Boat electrofisher (1) | 468          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 12     | 15-Oct-08 | Boat electrofisher (2) | 499          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 13     | 15-Oct-08 | Boat electrofisher (3) | 470          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 14     | 15-Oct-08 | Boat electrofisher (4) | 490          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 15     | 15-Oct-08 | Boat electrofisher (5) | 474          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 16     | 15-Oct-08 | Boat electrofisher (6) | 440          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 17     | 15-Oct-08 | Boat electrofisher (7) | 422          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 18     | 15-Oct-08 | Boat electrofisher (8) | 477          | Seconds                  | E-fishing Boat, Small - 4.27m, 5.0 GPP, single boom  |
| 19     | 16-Oct-08 | Bag seine (2)          | 3            | Haul                     | Bag Seine, 6.35mm Ace mesh, Length - 8.5m            |
| 20     | 16-Oct-08 | Bag seine (3)          | 3            | Haul                     | Bag Seine, 6.35mm Ace mesh, Length - 8.5m            |
| 21     | 16-Oct-08 | Bag seine (4)          | 3            | Haul                     | Bag Seine, 6.35mm Ace mesh, Length - 8.5m            |

Appendix 2. Summary of aquatic vegetation data for 2008 Big Creek sampling. Site # corresponds to Figure 1.

| Site # | Field number | Air temperature (°C) | Water temperature (°C) | Conductivity (µS) | Secchi depth (m) | Aquatic Veg Type1 | Aquatic Veg 1 (%) | Aquatic Veg Type2 | Aquatic Veg 2 (%) |
|--------|--------------|----------------------|------------------------|-------------------|------------------|-------------------|-------------------|-------------------|-------------------|
| 1      | BGCK001      | 21.4                 | 20                     | 466               |                  | None              | 100               |                   |                   |
| 2      | BGCK002      | 22.4                 | 20.5                   | 485               |                  | Submergent        | 20                | Emergent          | 20                |
| 3      | BGCK003      | 26                   | 20.5                   | 492               |                  | None              | 100               |                   |                   |
| 4      | BGCK004      | 25                   | 21.5                   | 496               |                  | None              | 100               |                   |                   |
| 5      | BGCK005      | 16.3                 | 12.4                   | 165               | 1.23             | Emergent          | 60                |                   |                   |
| 6      | BGCK006      | 19.1                 | 15.8                   | 397               | 0.35             | None              | 100               |                   |                   |
| 7      | BGCK007      | 20.6                 | 16.8                   | 633               | 0.08             | None              | 100               |                   |                   |
| 8      | BGCK008      | 23.2                 | 19                     | 524               | 0.29             | Emergent          | 90                | Submergent        | 10                |
| 9      | BGCK009      | 23.8                 | 19.4                   | 518               | 0.31             | Emergent          | 80                | Submergent        | 20                |
| 10     | BGCK010      | 22.8                 | 20                     | 516               | 0.35             | Emergent          | 50                | Floating          | 50                |
| 11     | BGCK001      | 15.9                 | 13.5                   | 550               |                  | Submergent        | 90                | Floating          | 10                |
| 12     | BGCK002      | 17.4                 | 13.6                   | 547               |                  | Submergent        | 100               |                   |                   |
| 13     | BGCK003      | 19.3                 | 14.2                   | 546               |                  | Emergent          | 60                | Submergent        | 40                |
| 14     | BGCK004      | 21.4                 | 13.8                   | 542               |                  |                   |                   |                   |                   |
| 15     | BGCK005      | 19.2                 | 13.7                   | 545               |                  | None              | 100               |                   |                   |
| 16     | BGCK006      | 19                   | 14.3                   | 532               |                  | Emergent          | 60                | Submergent        | 40                |
| 17     | BGCK007      | 20.8                 | 13.7                   | 557               |                  | None              | 100               |                   |                   |
| 18     | BGCK008      | 21.1                 | 14.1                   | 542               |                  | Submergent        | 100               |                   |                   |
| 19     | BGCK001      | 14.8                 | 12.9                   | 550               |                  | None              | 100               |                   |                   |
| 20     | BGCK002      | 14.4                 | 12.9                   | 550               |                  | None              | 100               |                   |                   |
| 21     | BGCK003      | 14.1                 | 13.4                   | 527               |                  | None              | 100               |                   |                   |

Appendix 3. Summary of substrate, width, depth, habitat, and flow data for 2008 Big Creek sampling. Site # corresponds to Figure 1.

| Site # | Substrate type 1 | Substrate 1 (%) | Substrate type 2 | Substrate 2 (%) | Stream width (m) | Max stream depth (m) | Distance from shore (m) | Max sampling depth (m) | Habitat type | Flow rate |
|--------|------------------|-----------------|------------------|-----------------|------------------|----------------------|-------------------------|------------------------|--------------|-----------|
| 1      | Silt             | 100             |                  |                 | 20               | 2                    | 15                      | 2+                     | not recorded |           |
| 2      |                  |                 |                  |                 | 25               | 2+                   | 15                      | 2                      | Run          | Slow      |
| 3      | Silt             | 90              | Clay             | 10              | 25               | 7.25                 | 17                      | na                     | Run          | Slow      |
| 4      | Silt             | 100             |                  |                 | 15               | 2+                   | 10                      | 2                      | Run          | Medium    |
| 5      | Silt             | 80              | Sand             | 20              | 2                | 5.6                  |                         |                        |              | Slow      |
| 6      | Sand             | 100             |                  |                 | 2                | 0.34                 |                         | 0.34                   | Run          | Medium    |
| 7      | Sand             | 80              | Silt             | 20              |                  | 0.81                 |                         |                        | Pool         | None      |
| 8      | Silt             | 100             |                  |                 | 44               | 2                    | 1.5                     | na                     | Run          | Slow      |
| 9      | Silt             | 80              | Organic          | 20              | 30               |                      |                         |                        |              |           |
| 10     | Silt             | 100             |                  |                 | 31               | 2+                   | 15                      | 2                      | Run          | Slow      |
| 11     |                  |                 |                  |                 | 29               | 2                    | 0                       | 2                      | Run          | Slow      |
| 12     |                  |                 |                  |                 | 25               | 2                    | 0-10                    | 2                      | Run          | Slow      |
| 13     |                  |                 |                  |                 | 32               | 2                    | 0-10                    | 2                      | Run          | Slow      |
| 14     |                  |                 |                  |                 | 15               | 1.8                  | 0-5                     | 1.8                    | Run          | Slow      |
| 15     |                  |                 |                  |                 | 22               |                      |                         | 2                      | Run          | Slow      |
| 16     |                  |                 |                  |                 | 26               | 2                    | 0-10                    | 2                      | Run          | Slow      |
| 17     |                  |                 |                  |                 | 19               | 2                    | 0-5                     | 2                      | Run          | Slow      |
| 18     |                  |                 |                  |                 | 33               | 2+                   | 0-10                    | 2                      | Run          | Slow      |
| 19     |                  |                 |                  |                 | 15               | 2+                   | 0-15                    | 1.5                    | Run          | Slow      |
| 20     |                  |                 |                  |                 |                  |                      |                         |                        | Run          | Slow      |
| 21     |                  |                 |                  |                 | 18               | 2+                   | 0-15                    | 1.5                    | Run          | Medium    |

Appendix 4. Summary of riparian vegetation, bank slope, and channel cover for 2008 Big Creek sampling. Site # corresponds to Figure 1.

| Site # | Riparian veg type1 | Riparian veg 1 (%) | Riparian veg type2 | Riparian veg 2 (%) | Riparian veg type3 | Riparian veg 3 (%) | Bank slope (%) | Channel cover (%) |
|--------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|----------------|-------------------|
| 1      | Deciduous          | 80                 | Grasses            | 20                 |                    |                    | 15             |                   |
| 2      | Deciduous          | 70                 | Grasses            | 20                 | Shrubs             | 10                 | not recorded   |                   |
| 3      | Grasses            | 70                 | Deciduous          | 30                 |                    |                    | 30             | 30                |
| 4      | Deciduous          | 80                 | Grasses            | 20                 |                    |                    | 25             | 60                |
| 5      | not recorded       |                    |                    |                    |                    |                    | 20             | 20                |
| 6      | Deciduous          | 100                |                    |                    |                    |                    | 60             | 95                |
| 7      | Deciduous          | 90                 | Grasses            | 10                 |                    |                    | 30             | 80                |
| 8      | not recorded       |                    |                    |                    |                    |                    |                |                   |
| 9      | Deciduous          | 100                |                    |                    |                    |                    | 0              | 0                 |
| 10     | Deciduous          | 60                 | Grasses            | 40                 |                    |                    | 0              | 0                 |
| 11     | Deciduous          | 60                 | Grasses            | 30                 | Shrubs             | 10                 | 0              | 0                 |
| 12     | Deciduous          | 60                 | Grasses            | 30                 | Shrubs             | 10                 | 10             | 15                |
| 13     | Deciduous          | 60                 | Shrubs             | 30                 | Grasses            | 10                 | 15             | 5                 |
| 14     | not recorded       |                    |                    |                    |                    |                    |                |                   |
| 15     | Deciduous          | 80                 | Grasses            | 10                 | Shrubs             | 10                 | 5              | 10                |
| 16     | Deciduous          | 70                 | Grasses            | 30                 | not recorded       |                    |                |                   |
| 17     | Deciduous          | 70                 | Grasses            | 30                 |                    |                    | 20             | 50                |
| 18     | Deciduous          | 70                 | Grasses            | 20                 | Shrubs             | 10                 | 25             | 20                |
| 19     | Deciduous          | 20                 | Grasses            | 30                 |                    |                    | 30             | 5                 |
| 20     | Deciduous          | 60                 | Shrubs             | 30                 | Grasses            | 10                 | 80             | 25                |
| 21     | Grasses            | 70                 | Shrubs             | 20                 | Deciduous          | 10                 | 45             | 0                 |

Appendix 5. Summary of species collected by site in the 2008 Big Creek sampling. Scientific and common names according to Page et al. (2013). Sites 1-21 correspond to numbers in Figure 1. Species currently listed under the Species at Risk Act have been greyed out.

| Common Name       | Scientific Name                     | Sites |   |     |   |   |   |    |     |    |    |    |     |    |    |    |    |    |    |    |    |    | Total |
|-------------------|-------------------------------------|-------|---|-----|---|---|---|----|-----|----|----|----|-----|----|----|----|----|----|----|----|----|----|-------|
|                   |                                     | 1     | 2 | 3   | 4 | 5 | 6 | 7  | 8   | 9  | 10 | 11 | 12  | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |       |
| Gizzard Shad      | <i>Dorosoma cepedianum</i>          |       |   |     |   |   |   |    | 1   |    |    |    |     |    |    |    |    |    |    |    |    |    | 1     |
| Spotfin Shiner    | <i>Cyprinella spiloptera</i>        |       |   | 7   |   |   |   |    |     |    |    |    |     |    |    |    |    |    |    |    |    |    | 7     |
| Common Carp       | <i>Cyprinus carpio</i>              |       |   |     |   |   |   |    |     |    |    |    | 11  | 1  |    |    |    |    |    |    |    |    | 12    |
| Golden Shiner     | <i>Notemigonus crysoleucas</i>      |       |   |     |   |   |   |    |     |    | 1  |    |     |    |    |    |    |    |    |    |    |    | 1     |
| Pugnose Shiner    | <i>Notropis anogenus</i>            |       |   |     |   |   |   |    | 5   |    | 1  |    |     |    |    |    |    |    |    |    |    |    | 6     |
| Emerald Shiner    | <i>Notropis atherinoides</i>        | 1     |   |     |   |   |   |    | 2   | 2  | 2  |    | 4   |    |    |    |    |    | 1  |    |    |    | 12    |
| Blacknose Shiner  | <i>Notropis heterolepis</i>         |       |   |     |   |   |   |    | 11  |    |    |    |     |    |    |    |    |    |    |    |    |    | 11    |
| Spottail Shiner   | <i>Notropis hudsonius</i>           |       | 1 |     |   |   |   |    |     |    |    | 1  |     |    |    |    |    |    |    |    |    |    | 2     |
| Mimic Shiner      | <i>Notropis volucellus</i>          | 1     | 2 |     |   |   |   |    | 6   | 13 | 1  |    |     | 3  |    |    |    | 1  |    | 2  |    |    | 29    |
| Bluntnose Minnow  | <i>Pimephales notatus</i>           |       |   |     |   |   |   |    | 110 | 1  |    |    | 1   |    | 3  |    |    |    |    |    |    |    | 112   |
| Fathead Minnow    | <i>Pimephales promelas</i>          |       |   |     |   |   |   | 1  |     |    |    |    |     |    |    |    |    |    |    |    |    |    | 1     |
| Blacknose Dace    | <i>Rhinichthys atratulus</i>        |       |   |     |   | 4 |   |    |     |    |    |    |     |    |    |    |    |    |    |    |    |    | 4     |
| Creek Chub        | <i>Semotilus atromaculatus</i>      |       |   |     |   | 1 |   | 56 |     |    |    |    |     |    |    |    |    |    |    |    |    |    | 57    |
| White Sucker      | <i>Catostomus commersonii</i>       |       |   |     |   | 2 | 1 | 18 |     |    |    |    |     |    |    | 1  |    | 1  |    |    |    |    | 23    |
| Lake Chubsucker   | <i>Erimyzon sucetta</i>             |       |   |     |   |   |   |    |     |    | 2  |    |     |    |    |    |    |    |    |    |    |    | 2     |
| Brown Bullhead    | <i>Ameiurus nebulosus</i>           |       |   |     |   |   |   |    |     |    |    |    |     |    |    |    |    | 1  |    |    |    |    | 1     |
| Rainbow Trout     | <i>Oncorhynchus mykiss</i>          |       |   |     |   | 1 | 6 |    |     |    |    |    |     |    |    | 1  |    |    |    |    |    |    | 8     |
| Grass Pickerel    | <i>Esox americanus vermiculatus</i> |       |   |     |   |   |   |    |     |    |    | 1  |     |    |    |    | 1  |    |    |    |    |    | 2     |
| Northern Pike     | <i>Esox lucius</i>                  |       |   |     |   |   |   | 4  | 1   | 3  | 1  | 3  |     | 1  | 1  |    |    | 1  |    |    |    |    | 15    |
| Central Mudminnow | <i>Umbra limi</i>                   |       |   |     |   |   |   |    |     |    |    |    |     | 1  |    |    |    |    |    |    |    |    | 1     |
| Brook Silverside  | <i>Labidesthes sicculus</i>         |       | 2 | 123 |   |   |   |    | 19  | 10 | 8  | 57 | 139 | 11 | 35 | 16 | 23 | 12 | 14 | 3  |    |    | 472   |
| Banded Killifish  | <i>Fundulus diaphanus</i>           |       |   |     |   |   |   |    |     |    |    | 1  |     |    |    |    |    |    |    |    |    |    | 1     |
| Mottled Sculpin   | <i>Cottus bairdii</i>               |       |   |     |   | 8 |   |    |     |    |    |    |     |    |    |    |    |    |    |    |    |    | 8     |
| Rock Bass         | <i>Ambloplites rupestris</i>        |       |   |     |   |   |   |    | 1   | 4  |    |    |     | 1  |    |    |    |    |    |    |    |    | 6     |
| Pumpkinseed       | <i>Lepomis gibbosus</i>             |       |   |     |   |   |   |    | 7   | 25 | 1  |    |     |    |    |    |    |    |    |    |    |    | 33    |

Appendix 5. Continued

| Common Name         | Scientific Name               | Sites    |          |            |          |           |          |           |            |           |           |           |            |           |           |           |           |           |           |          |          |          | Total      |
|---------------------|-------------------------------|----------|----------|------------|----------|-----------|----------|-----------|------------|-----------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|------------|
|                     |                               | 1        | 2        | 3          | 4        | 5         | 6        | 7         | 8          | 9         | 10        | 11        | 12         | 13        | 14        | 15        | 16        | 17        | 18        | 19       | 20       | 21       |            |
| Bluegill            | <i>Lepomis macrochirus</i>    |          |          |            |          |           |          |           | 1          | 5         | 2         |           |            |           |           |           |           |           |           |          |          |          | 8          |
| Sunfish Hybrid      | <i>Lepomis</i> sp.            |          |          |            |          |           |          |           |            |           | 1         |           |            |           |           |           |           |           |           |          |          |          | 1          |
| Largemouth Bass     | <i>Micropterus salmoides</i>  |          |          | 3          |          |           |          |           | 10         | 10        | 2         | 2         |            |           |           |           |           |           |           |          |          |          | 27         |
| Eastern Sand Darter | <i>Ammocrypta pellucida</i>   |          |          | 1          | 1        |           |          |           |            |           |           |           |            |           |           |           |           |           |           |          |          |          | 2          |
| Johnny Darter       | <i>Etheostoma nigrum</i>      |          |          | 13         | 3        |           |          |           |            |           |           |           |            |           |           |           |           |           |           |          |          |          | 16         |
| Yellow Perch        | <i>Perca flavescens</i>       |          | 1        |            | 2        |           |          |           | 5          | 11        | 3         |           |            |           |           |           |           |           |           | 1        |          |          | 23         |
| Blackside Darter    | <i>Percina maculata</i>       |          | 1        |            |          |           |          |           |            |           |           |           |            |           |           |           |           |           |           |          |          |          | 1          |
| Freshwater Drum     | <i>Aplodinotus grunniens</i>  |          |          |            |          |           |          |           |            |           |           |           |            |           |           | 1         |           |           |           |          |          |          | 1          |
| Round Goby          | <i>Neogobius melanostomus</i> |          |          |            | 1        |           |          |           | 5          | 7         |           |           |            |           |           |           |           |           |           |          |          |          | 13         |
| <b>Total</b>        |                               | <b>2</b> | <b>7</b> | <b>147</b> | <b>7</b> | <b>16</b> | <b>6</b> | <b>79</b> | <b>184</b> | <b>91</b> | <b>25</b> | <b>65</b> | <b>155</b> | <b>18</b> | <b>36</b> | <b>19</b> | <b>24</b> | <b>16</b> | <b>15</b> | <b>6</b> | <b>0</b> | <b>0</b> | <b>873</b> |

Appendix 6. Site location data for 2008 Big Creek sampling. Site # corresponds to Figure 1. Geographic coordinates (latitude and longitude) are provided in decimal degrees (dd).

| Site # | Field number | Date      | Waterbody name | Narrative locality description                                    | Latitude (dd) | Longitude (dd) |
|--------|--------------|-----------|----------------|-------------------------------------------------------------------|---------------|----------------|
| 1      | BGCK001      | 19-Aug-08 | Big Creek      | 350m u/s of Port Royal bridge                                     | 42.59769      | -80.48656      |
| 2      | BGCK002      | 19-Aug-08 | Big Creek      |                                                                   | 42.59909      | -80.48956      |
| 3      | BGCK003      | 19-Aug-08 | Big Creek      | 500m d/s of concession road 1                                     | 42.60705      | -80.51130      |
| 4      | BGCK004      | 19-Aug-08 | Big Creek      |                                                                   | 42.61553      | -80.52209      |
| 5      | BGCK005      | 20-Aug-08 | Big Creek      | Fertilizer Road                                                   | 42.83581      | -80.46359      |
| 6      | BGCK006      | 20-Aug-08 | Big Creek      |                                                                   | 42.73436      | -80.50089      |
| 7      | BGCK007      | 20-Aug-08 | Hahn's Ditch   |                                                                   | 42.59309      | -80.52177      |
| 8      | BGCK008      | 21-Aug-08 | Big Creek      | Big Creek channel approx. 1 km u/s of Hwy. 59 bridge 1            | 42.59437      | -80.46412      |
| 9      | BGCK009      | 21-Aug-08 | Big Creek      |                                                                   | 42.59344      | -80.47011      |
| 10     | BGCK010      | 21-Aug-08 | Big Creek      |                                                                   | 42.59348      | -80.47177      |
| 11     | BGCK001      | 15-Oct-08 | Big Creek      | just u/s of NWA boundary                                          | 42.59354      | -80.47072      |
| 12     | BGCK002      | 15-Oct-08 | Big Creek      |                                                                   | 42.59319      | -80.47800      |
| 13     | BGCK003      | 15-Oct-08 | Big Creek      |                                                                   | 42.59494      | -80.48626      |
| 14     | BGCK004      | 15-Oct-08 | Big Creek      |                                                                   | 42.59975      | -80.49289      |
| 15     | BGCK005      | 15-Oct-08 | Big Creek      |                                                                   | 42.59759      | -80.48934      |
| 16     | BGCK006      | 15-Oct-08 | Big Creek      |                                                                   | 42.59655      | -80.48670      |
| 17     | BGCK007      | 15-Oct-08 | Big Creek      |                                                                   | 42.59577      | -80.48254      |
| 18     | BGCK008      | 15-Oct-08 | Big Creek      |                                                                   | 42.59323      | -80.47466      |
| 19     | BGCK001      | 16-Oct-08 | Big Creek      |                                                                   | 42.60132      | -80.49253      |
| 20     | BGCK002      | 16-Oct-08 | Big Creek      |                                                                   | 42.62357      | -80.53319      |
| 21     | BGCK003      | 16-Oct-08 | Big Creek      |                                                                   | 42.61757      | -80.52791      |
| 22     | NA           | 20-Aug-08 | Big Creek      | Historical location; near the mouth of Big Creek. Did not sample. | 42.60156      | -80.44934      |

| Site # | Field number | Date      | Waterbody name | Narrative locality description                                                                | Latitude (dd) | Longitude (dd) |
|--------|--------------|-----------|----------------|-----------------------------------------------------------------------------------------------|---------------|----------------|
| 23     | NA           | 20-Aug-08 | Big Creek      | Historical location; Concession Road 2, by Rowan Mills. Site was dry.                         | 42.61511      | -80.53820      |
| 24     | NA           | 20-Aug-08 | Big Creek      | Historical location; near Forestry Farm Road and St. John's Rd. W intersection. Site was dry. | 42.73199      | -80.46604      |
| 25     | NA           | 20-Aug-08 | Big Creek      | Historical location; site located off of Rhineland Road. Site was dry.                        | 42.77667      | -80.49667      |
| 26     | NA           | 20-Aug-08 | Big Creek      | Historical location; Windham W. ¼ Line; south of Wilson Avenue; east of Delhi. Site was dry.  | 42.84444      | -80.45278      |